Nutritional strategies to support muscle maintenance in clinical population

VALORIZATION

"*Knowledge valorization refers to the process of creating value from knowledge, by making knowledge suitable and/or available for social (and/or economic) use and by making knowledge suitable for translation into competitive products, services, processes, and new commercial activities*" (National Valorization Committee 2011:8).

Relevance

Due to the progressive aging of the population and the greater longevity, the subpopulation of older individuals is currently the fastest growing population in the developed world [1]. In the Netherlands, most recent predictions show that 33% of the population will be older than 60 in 2050, and nearly 10% aged over 80 years old [2, 3]. The increasing aging population can be seen as a success for public health policies and socioeconomic development, but it also challenges society to improve health and functional capacity in older people and stimulate their social participation. Moreover, with the rise in the aged population there will be an increase in health care costs to cover the prevention, treatment, and hospitalization-associated costs of non-communicable and age-related diseases [2].

Hospitalization, often required due to illness or surgery, is associated with increased health care costs. For example, the cost of one hospital bed per day in the Netherlands is 500 euro, based on primary, secondary, and tertiary hospitals [4]. At present, the average hospitalization duration is 5 days [5]. However, the length of hospitalization increases with an advancing age from the age of 40 [5]. Short periods of bedrest or hospitalization have been shown to induce substantial muscle loss (**chapter 2** and [6, 7]). The amount of muscle tissue at time of hospital admission as well as the amount of muscle tissue lost during hospitalization predict mortality and clinical outcomes [8-10]. In addition, following a period of hospitalization, muscle disuse atrophy often carries over at home during the subsequent period of recovery. Importantly, it has been shown that recovery in older individuals is impaired when compared with younger individuals [11]. Subsequent (short) periods of muscle disuse atrophy in older individuals are therefore suggested to contribute to the age-related loss in muscle mass and strength, termed sarcopenia [6]. From 2016, sarcopenia has been recognized as a disease entity and has been given an ICD-10-CM code, meaning that there will be a demand for the availability of diagnostic tools, treatments, and intervention strategies to prevent and treat the emergence of sarcopenia.

Health care implementation

Nowadays, hospitals in the Netherlands have more daycare patients than in-patients. Moreover, patients are dismissed earlier, as evidenced by the reduction of average hospital length of stay from 7.5 days in 2003 to 5.2 days in 2013 [5]. This places a higher burden on the responsibility and the self-direction of the patient for recovery at home or in rehabilitation

centers, as well as a multimodal approach for the integrated care to supervise patients from home, troughout hospitalization, back to home. Since more of the current health care is shifting from primary care towards secondary and tertiary health services, an efficient, multidisciplinary, integrated health care system is essential. Recently, more programs have been developed to prepare patients prior to a period of hospitalization by pre-habilitation training and nutritional support; examples of this are 'Fit4surgery' and 'Better in better out' concepts. Such a pre-habilitation program is not only an effective tool to increase physical and nutritional status of the patient; it also puts more accountability and motivation on patients. In addition, hospitals have introduced fast track surgeries and more daycare treatments for the fittest patients in order to be treated faster, on times outside regular hours, and to be dismissed earlier. This requests direct supervision during pre-habilitation and recovery in the home-based setting, including medical, nutritional, physical, social, and psychological support. Education towards the patients is essential in this case and all health care workers will have to carry out the same message in order to support integrated care.

This thesis provides insight in the absolute amount of muscle mass loss and nutritional intake during merely a few days of hospitalization in older patients (**chapter 2** and **3**). Even though there is an increasing amount of evidence on the negative health consequences of hospitalization in the older population, our findings have not yet been generalized and translated to the general public. Therefore, awareness amongst patients on the relevance of nutrition and physical activity should be created. Secondly, it is the task of physicians and health care workers to educate their patients on this. During hospital stay, patients spend about 80% of their day in bed, their food is served at the bedside, and appointments with physicians and health care workers take place in the patients' room [12, 13]. Indeed, older patients during hospitalization spend a mere 43 minutes per day standing or walking [12-14], and there is a clear role here for policy makers and the logistics in hospitals to encourage physical activity during hospitalization. Some hospitals in the Netherlands have started with creating attractive walking routes, gardens, and outside training equipment, which will be continued in more hospitals and nursing homes. The intrinsic motivation and patients' journey throughout hospitalization differs per patient, which does not require a one-size-fits-all advice and treatment. Therefore, a proper assessment of motivation, functional, and nutritional status in the pre- to post- clinical phase is essential to improve the treatment and supervision of the patient.

Products and meal services

The present thesis discusses several nutritional strategies to increase protein intake in older and clinically compromised individuals (**chapter 6**-**8**). The ingestion of dietary protein has been shown to stimulate muscle protein synthesis, and as such, is a key regulator in the maintenance of muscle mass with aging and in clinical populations. Acute changes in food intake can dramatically decrease protein intake and contribute to muscle mass and strength loss in the older and clinically compromised population.

Pre-sleep protein ingestion can likely serve as an effective strategy to increase overall protein intake in the older population. We show in **chapter 7** that protein ingested prior to sleep is effectively digested and absorbed and increases overnight muscle protein synthesis rates. The ingestion of 40 g protein significantly increased overnight muscle protein synthesis rates. Since 40 g of protein (e.g. >1 L of milk) is likely difficult to consume prior to sleep by the general elderly population, technological advances towards protein-dense and low-volume products are necessary here to develop and improve pre-sleep protein products for healthy and diseased older individuals. Moreover, protein intake during hospitalization and institutionalization is generally reduced in the majority of the elderly. Still 40% of the patients are malnourished during hospitalization and in nursing homes [15, 16]. Pre-sleep protein ingestion can serve as an effective strategy to increase overall protein intake or cover energy and protein deficits during the first days of illness or in the pre- and peri-operative period. In addition, an evening serving round with protein-rich evening snacks can be relatively easily implemented in hospitals and nursing homes. However, here lies a call for product developers to produce specific pre-sleep nutritional products such as protein-rich snacks and drinks. The quality and attractiveness of meal services in hospitals and nursing homes is generally poor. New meal service concepts such as room service, buffet-style meals, meal orders upon request, mealtime assistance, and restaurant-style meal provisions have been developed [17-20]. Room service dining and attractive meals have been shown to increase food intake, improve patient satisfaction, and reduce food waste in hospitals [17, 18, 20, 21]. Whilst these strategies provide interesting opportunities to decrease waste, more specific strategies to increase the protein content, source, taste, appearance, and timing of the meals are essential to increase the protein density of the diet. It is crucial that food intake is thoroughly monitored during hospitalization. With these new meal service concepts such as 'ordering upon request', food intake per patient can be directly monitored in order to tailor individualized dietary intake plans and directly advise towards the individual patient's needs and intake of that day. Nutritional assistants will have to play a central role in the nutritional support of the patient in order to provide patients with attractive meals and monitor nutritional intake.

Recommendations

The presented data in this dissertation provide many leads and targets for product development and innovations in the nutrition industry and health care. Since parts of this thesis have been conducted within the framework of TIFN, a public-private partnership, research findings have been shared with industrial partners throughout the last years. As such, a transparent platform is already in place for industries to directly implement the research findings into innovations.

To stimulate the implementation in health care, we present 10 key points on a separate flyer summarizing the main findings and recommendations from the present thesis. These will be distributed to several Dutch hospitals, nutritional companies, and Universities to be used as factsheets for health care professionals, patients, nutrition industry, and policy makers.

The key recommendations from this thesis include:

1. Nutritional intervention strategies should be combined with more physical activity before, during, and after hospitalization.
2. Early pre-habilitation interventions that include exercise training and protein supplementation should be implemented to improve clinical outcomes during hospitalization in older patients.
3. Since 40% of the provided hospital meals is not consumed, more protein-rich foods and attractive meal service concepts need to be provided to the patient to increase protein intake.
4. To reach protein intake recommendation levels of 1.2 $g \cdot kg^{-1} \cdot d^{-1}$ for older patients, a more protein-dense diet will be required.
5. More specific nutritional interventions throughout hospitalization are needed; nutritional supplementation can cover energy and protein deficits in the acute (operative) period while the subsequent days will require the focus on the increase in protein intake mainly through the diet.
6. Pre-sleep protein ingestion can be a useful strategy to provide extra protein on the evening prior to surgery and during evening rounds on the ward.
7. An attractive environment using walking routes and gardens could be offered in hospitals to encourage patients to be more physically active during hospitalization.
8. Hospital meals need to be attractive, adequately nutritious, and patient-specific.
9. Rehabilitation strategies need to be continued on the long term and should combine a functional exercise training regimen with proper nutritional support.
10. A multimodal approach will maximize the intrinsic motivation of the patient.

Personal perspective

Throughout my PhD trajectory, it became clear to me that there is an enormous amount of scientific research done on nutrition and muscle metabolism, however less is known on the practical implementation towards clinical health care. There is a gap between scientific research findings on one hand, and clinical bedside applicable research on the other hand. The collaboration between academic institutes and health care professionals as well as policy makers and nutrition companies is essential to investigate intervention strategies and facilitate the practical implementation. I am looking forward to, in the upcoming years, further conduct high quality research to gain knowledge on the role of (clinical) nutrition, that can be directly translated into practical advice and guidelines to dieticians, health care workers, and patients. I believe that dieticians, physicians, and scientists should collaborate to address research questions that are directly relevant to health care and patients, where a multimodal approach is key. Last but not least, there is currently enough insight to innovate health care and apply a more pro-active approach including pre- and post-hospitalization reconditioning of older patients. We should start today!

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